492

VOLUME 80 SEPARATE No. 492

PROCEEDINGS

AMERICAN SOCIETY
OF
CIVIL ENGINEERS

SEPTEMBER, 1954

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

WASTE DISPOSAL AT A STEEL PLANT: GENERAL PROBLEMS

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SANITARY ENGINEERING DIVISION

{Discussion open until January 1, 1955}

Headquarters of the Society
33 W. 39th St.
New York 18, N. Y.

PRICE $0.50 PER COPY

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This paper was published at 1745 S. State Street, Ann Arbor, Mich., by the American Society of Civil Engineers. Editorial and General Offices are at 33 West Thirty-ninth Street, New York 18, N. Y.

WASTE DISPOSAL AT A STEEL PLANT: GENERAL PROBLEMS

Ross Nebolsine,[1] M. ASCE

I. Scope

This symposium will deal with the design, construction and putting into operation the comprehensive industrial wastes and sewage treatment facilities for the new Fairless Works which is a large, modern integrated steel mill located at Morrisville, Pennsylvania.

The initial presentation reviews the general aspects of the problem, the governing design factors, the main features of the project and the results achieved. Four other papers will cover the following phases of the project:

a) Flue Dust Treatment
b) Sheet and Tin Mill Wastes Treatment
c) Terminal Treatment Plant
d) Sanitary Sewage Treatment

II. Development of Steel Plant

Just three years ago the Fairless Project was started. In the first year the designs were worked out and the very extensive earth works completed. During the second year, most of the installations were constructed.

This last year has seen the successful completion and placing into operation of the various manufacturing facilities of the mill and the corresponding wastes treatment installations.

The steel plant is designed for 1,800,000 ingot tons annual capacity. This is comprised of two blast furnaces, nine open hearths, a two battery coke plant, hot rolling mills, sheet and tin mill, and other finishing equipment. There are also pipe producing facilities separately designed and operated by the National Tube Division of the United States Steel Corporation.

III. Nature of Technical Problem

From the beginning, the United States Steel Corporation recognized that the quality of the water of the Delaware River, on the right bank of which the Works are located, should be preserved. To achieve this objective, great care was taken in laying out and designing the necessary installations that would provide adequate treatment of the industrial waste waters originating in the mill.

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The engineering task that had to be faced with regard to the wastes may best be judged by listing the governing factors of the problem in two separate categories. In the first category are the design considerations that complicated the problem; and in the second, the elements that favored working out effective wastes treatment facilities at a reasonable cost.

The difficult aspects of the problem were as follows:

a) The large quantity of waste water to be treated. For the present stage this was estimated to be 55,000 gpm, but for the future development, provisions had to be made for a total of 120,000 gpm. Respectively, this represents about 1/3 of the total water requirements of 170,000 gpm for the first stage; and some 25% or 30% of the estimated 400,000 gpm total circulated supply for the future development.

b) An unusually large number of separate waste water discharges scattered over 2,000 acres. These comprise 43 distinct outflows consisting of over a dozen entirely different chemical compositions or types.

   These comprise:

4 Acids	Sulphuric Chromic Hydrochloric Phosphoric
2 Alkalis	Sodium Ortho-silicate Sodium Carbonate
3 Soluble Oils (Emulsions)	Rolling Solution Precipitron Oil Cutting & Grinding Solutions
2 Insoluble Oils (Floating)	Palm Oil Lube Oils & Greases
Mill Scale	
Flue Dust	

c) Uncertainty as to the actual chemical composition and rates of flow of the various wastes discharges of a plant that had yet to be built. The obtaining of reliable design data was further complicated by the necessity of obtaining it in part from so-called "area contractors" who were responsible for such important parts of the Works as blast furnaces, coke ovens, open hearths, etc.

d) The necessity of finding immediate solutions and preparing detailed designs, for the wastes treatment facilities without any time allowed for research or experimental work on discharges.

e) The high degree of treatment that United States Steel Corporation required to conform to its announced policy of maintaining the quality of the Delaware River water.

The favorable factors were as follows:

1) Early consideration of the problems and agreement on objectives before the basic steel producing facilities were definitely laid out. This permitted a large degree of freedom in the choice of treatment sites, processes and installations.
2) Unification of design of all water, drainage, sewerage and wastes treatment facilities.
3) Allowance of an adequate budget for these facilities and assignment of suitably located and sufficiently large areas for the different installation required. This was possible because of the large size of the site.
4) The great variety of wastes to be dealt with which permitted working out solutions wherein some of the discharges were used as means for treating some of the others.
5) The availability of extensive technical data and a wealth of industrial equipment to draw from which permitted working out a variety of processes, including some novel applications of standard facilities.
6) Excellent cooperation received from regulatory officials and from the engineering divisions of the United States Steel Corporation.

Basic Features of Design

Engineering studies were started in the middle of October, 1950. Within three months a comprehensive report, general plans, and estimates of costs of the water supply, drainage, sewerage, and wastes treatment facilities for the entire project were completed, and the sites, processes, and types of installations agreed upon.

The solution adopted was based on the following conceptions:

a) Separation of all sewage discharges from industrial wastes in a separate system including treatment facilities for sewage.
b) The treatment, close to their source, of wastes originating in two out of the three zones. In the case of the flue dust this provides completely separate handling; and in the other, necessary pre-treatment of certain parts of the flows.
c) Integration and coordination of the various steps in wastes treatment throughout the Works so that discharges pass successively through the proper installations for cumulative elimination of impurities.
d) Concentrating many wastes and sewage handling treatment steps at the River Site Area, at which are located the Main River Pumping Station, Central Controls Building, electric power, steam, and other facilities for efficient centralized and partly automatic operation.
e) Processes and equipment for the collection and commercial disposal of recoverable wastes. Some reclamation to be effected now and additional operations to be initiated in the future.
f) Utilization of large lagoons permitting supplementary sedimentation following passage through mechanical installations. Additional seration, sedimentation and equalization of composition by means of lagoons was feasible due to the space available and suitable topography of the site.

g) Setting aside areas for such additional facilities as multiple interconnections, by-passes, overflows, and possibility of re-pumping. Flexibility of operations consisting of provisions for changes in flows, modifications of processes or use of additional equipment if and when required.

Once the general layouts and designs were decided on and approved, the detailed designs were executed quite rapidly, except for delays in obtaining exact locations of and clearances with, the basic manufacturing facilities and other utilities which often competed for space.

Description of Waste Treatment Installations

Apart from sewerage, the bulk of the waste waters requiring treatment originate in three separate areas, the blast furnace area, the sheet and tin mill area, and the hot mill area.

First, let us consider blast furnace flue dust, which is primarily composed of fine iron ore. Water carries the flue dust from the gas washers, which are adjacent to the furnaces. As will be explained in the following papers, this flue dust is recoverable and can be fed to a sinter plant. It must be kept apart from all other wastes. The treatment process essentially consists of sedimentation which is done by thickeners in the furnace area. For the time being, the sludge will be discharged into an adjacent closed excavated area. The volume involved is about 10,000 gpm. More data on this phase of treatment will be presented in the second paper of this symposium.

Second, let us examine the sheet and tin mill wastes, including discharges from the adjoining pipe mill. In this area originate the greatest variety of wastes according to their composition. In order to facilitate the task of final treatment, a separate treatment plant is located close to the sources of these wastes.

How the relatively simple facilities originally contemplated grew into a unique complex of processes designed to help complement each other will be described in another paper.

Third, we come to the so-called hot mills. These consist of an 80-inch continuous strip mill, billet mill, slabbing, blooming, and bar mills. The wastes produced consist mainly of mill scale and oils. The so-called mill scale is almost pure iron oxide and must be recovered. The oils are mostly lubricating and roll grinding oils. Most of the scale is recovered by dredging out of the six separate scale pits which operate as small sedimentation basins. There are two additional scale pits in the pipe mill.

The lubricating and roll grinding oils are recovered at the Terminal Treatment works as will be further explained in a separate paper of the symposium.

Finally, there are a variety of miscellaneous and relatively small industrial wastes discharges in other parts of the plant. These will be directed towards two industrial wastes collector trunk sewers running to the River Site Area. The Terminal Wastes Treatment Facilities, as has been mentioned previously, are located in the River Site Area. These facilities comprise heavy scale trap, low lift pumping station, aeration basins, pre-sedimentation and oil skimming basins.

After this phase of treatment, the flow is directed into a settling basin, which for the time being, consists of the so-called Basin No. 2, ultimately destined for settling and storing raw river water. From this basin, the wastes discharge is directed into a large lagoon where several hours of additional retention are provided. The final discharge from the lagoon can be directed either into an outfall on the bank of the Delaware, or to the intake flume of the service water pumps of the main river pumping station. In this way, all or part of the reclaimed waste waters can be used in the service water system where cold temperature requirements are not of great importance.

Because of the arrangement described above, no final decision on the method of mechanical clarification of the wastes has been necessary. Experience will show whether chemical coagulation will be desirable, and that in turn, will decide the type of equipment required. A site has been provided to the north of the pre-sedimentation basin where circular or rectangular mechanical operated clarifiers can be built at a later stage when the second settling basin is required for water treatment or for any other reason. This will be done only if it is found necessary and economical to have such mechanical removal of the remaining suspended solids.

The variety of industrial wastes treated and the array of facilities described above is believed to be unique. The occupied area, including provisions for future installations is 40 acres.

Operating Results

Only long term observations on the composition of effluents from the various treatment installations can show to what extent the objectives described above have been achieved.

The degree of purification now actually accomplished is excellent, resulting in water comparable to that taken from the Delaware River.

The steel plant is still not in full production. Some adjustments may be desired on some of the treatment facilities as the period involved is too short to reach final conclusions. However, it is expected that the final affluents will be equal to or better than the quality of the Delaware River water. It may well be that certain adjustments, modifications or additions to the selected processes will later be found advisable. As has been mentioned previously, the exceptional flexibility of the design will allow doing this economically.

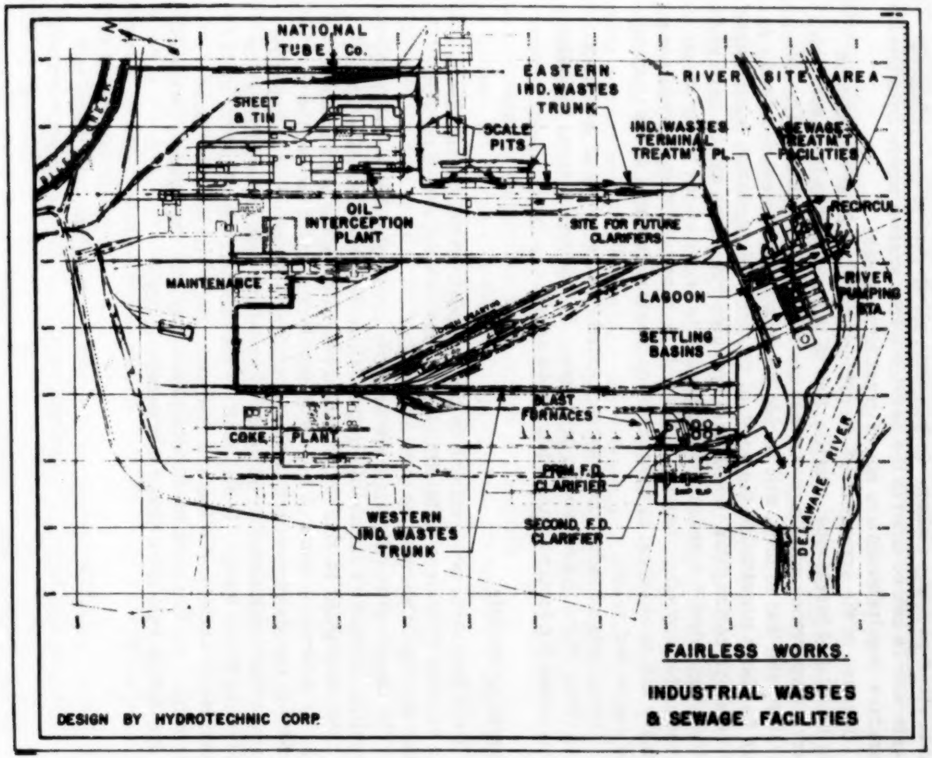


Fig. 1. - GENERAL PLAN OF WORKS

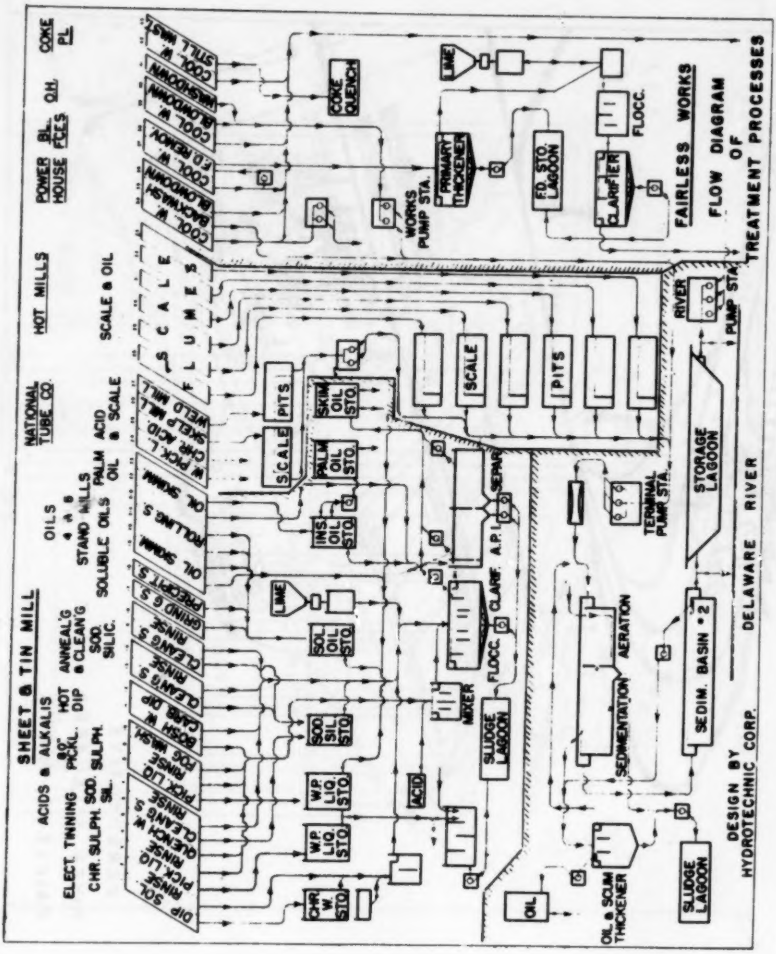
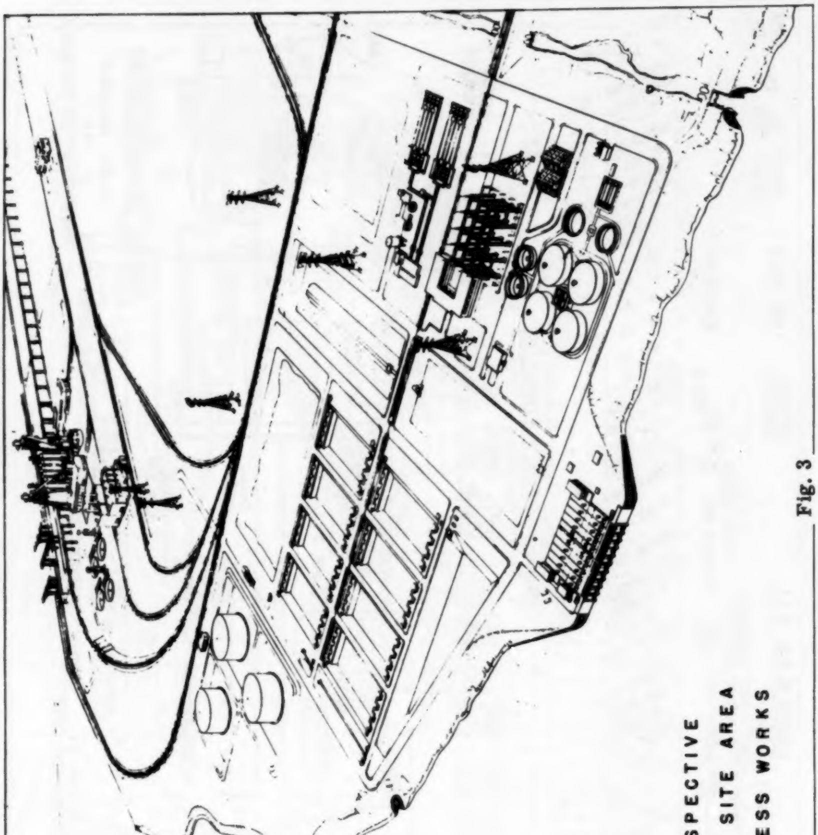


Fig. 2. - FLOW DIAGRAM



PERSPECTIVE
RIVER SITE AREA
FAIRLESS WORKS

Fig. 3

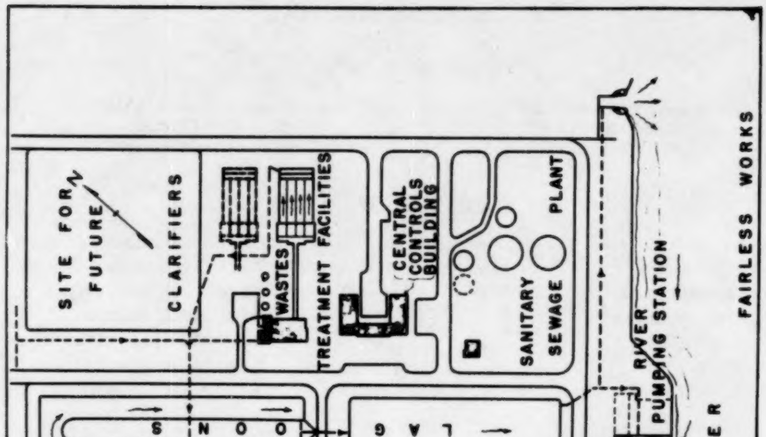

SITE FOR FUTURE CLARIFIERS
WASTES
TREATMENT FACILITIES
CENTRAL CONTROLS BUILDING
SANITARY SEWAGE PLANT
RIVER PUMPING STATION
L A G O O N S
BASIN USED FOR WASTES SEDIMENTATION
DELAWARE RIVER
RIVER SITE AREA
FAIRLESS WORKS

Fig. 4.